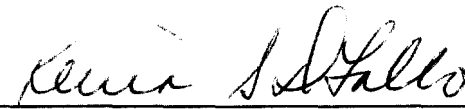adopt the proposed ACATS standard *only* with the refinements proposed herein

and in CICATS's initial Comments.

Respectfully submitted,

**COMPUTER INDUSTRY COALITION
ON ADVANCED TELEVISION
SERVICE**

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ECONOMIC CONSIDERATIONS FOR DIGITAL TELEVISION PROPOSALS:

Refinements and Sensitivities

prepared for the

Computer Industry Coalition
on Advanced Television Service

Lee L. Selwyn

August 12, 1996

ECONOMIC CONSIDERATIONS FOR DIGITAL TELEVISION PROPOSALS:

Refinements and Sensitivities

Lee L. Selwyn*

Introduction

In our earlier study, "Economic Considerations in the Evaluation of Alternative Digital Television Proposals,"[1] we presented estimates of the aggregate cost to consumers for the transition to digital television. Our analysis was based upon cost estimates developed by the Computer Industry Coalition on Advanced Television Service (CICATS) of the retail prices of set-top converters that could be used by consumers to receive digital television signals using their existing analog NTSC television receivers.[2] In preparing its estimates of retail prices, CICATS applied the following logic and assumptions:

- It assumed that the technical character, complexity, and capability of a set-top converter capable of receiving the CICATS base-line digital SDTV signal would be comparable to those for a digital satellite service (DSS) set-top decoder. DSS decoders have been selling at retail for between $500 and $700. For purposes of our study, CICATS assumed the lower end of this range. 15% of the cost of the CICATS converter was assumed to be associated with packaging and power supply components, while 85% was assumed to consist of VLSI (Very Large Scale Integration) electronics. 50% of the VLSI cost was assumed to be associated with the MPEG-2 decoder.

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1. Submitted as Appendix D to the July 11, 1996 *Comment* of CICATS.

2. See "Cost Comparison of ACATS and CICATS Set-top Converters. Receivers. and PC Decoders," Exhibit C to CICATS' July 11 Comments

- It assumed that the full-function ACATS HDTV-capable MPEG-2 decoder section will cost approximately five times as much as the decoder used in a SDTV DSS receiver. An ACATS HDTV MPEG-2 decoder would need to process data five times faster and would use five times more memory than is required for DSS. Hence, the cost of this component of the ACATS converter was assumed to be five times that for the comparable component of the CICATS unit.

- The initial (1996) retail prices of the CICATS and ACATS converters were thus assumed to be $500 and $1,350, respectively.

- It was assumed that, consistent with Moore's Law, the cost of the VLSI components of both types of converters would decrease by 50% every 24 months.

In developing our estimates of the aggregate cost to consumers for the transition to digital television, we made the following assumptions about the rate of acquisition of digital television converters:

- We assumed that only converters would be purchased, and thus did not include the additional costs of the digital television receivers (both SDTV and HDTV) that consumers would need to purchase in order to obtain the full functionality gains associated with DTV. We assumed that the sole objective of the consumer migration was to retain the ability to receive over-the-air broadcasts transmitted on the digital channels.

- We postulated an adoption rate for each year from 1998 through 2007, applying that rate to the then-remaining installed base of NTSC receivers that were not yet equipped with converters. The adoption rates we assumed for each of the ten years were 10%, 10%, 20%, 20%, 30%, 40%, 50%, 60%, 70% and 100%. We assumed that all analog broadcasts would cease after 2007.

- If the ACATS standard is adopted, we posited two alternative scenarios regarding the nature of ACATS set-top converters:

    (1) Only full-function HDTV-capable ACATS converters are offered.

    (2) Both full-function HDTV-capable and "stripped-down" SDTV-only ACATS converters are offered. In this case, we assumed that only 20% of consumers would purchase HDTV-capable units, and that the remaining 80% would be able to receive only SDTV signals. For the SDTV ACATS converters, we assumed that the cost of these would be roughly the same as for a CICATS base-line converter unit.

ECONOMICS AND
TECHNOLOGY, Inc.

On the basis of that study, we projected aggregate transition costs to consumer as follows:

- ACATS Scenario (1) [full-function HDTV units only]: $91.7-billion

- ACATS Scenario (2) [both HDTV- and SDTV-capable converters
  are offered]: $56.6-billion

- The CICATS base-line approach is adopted: $47.8-billion

Use of the DSS "retail price" as a basis for the cost estimates

The cost estimation method that we employed was a "tops-down" approach. In estimating the aggregate cost to consumers, the physical cost of manufacturing the converter units is only one element. The units have to be packaged, marketed, shipped to distributors and retailers, and sold and serviced at retail to the ultimate consumer. These "retailing" costs are, in turn, a function of the cost and complexity of the underlying product.

The typical experience in the consumer electronics industry is that the retail "street price" is roughly three times the manufacturing cost of the product itself. Hence, an alternative method for estimating the cost to consumers would have been to apply a "bottoms-up" product engineering analysis, and then multiply that result by three. We believe, however, that our tops-down approach is both reasonable and conservative.

We started with the low end of the range of retail prices of DSS converters. Due to the extensive externalities associated with a product such as a DSS converter (in terms of its effect upon the demand for direct broadcast satellite television services), it appears that the current retail prices may actually be subsidized either by the DBS broadcasters and/or by the equipment manufacturers. Such "subsidies" typically take the form of lower-than-normal margins at the manufacturing level or the payment of "bounty" to retailers. The latter practice, for example, is commonly used in the cellular industry to keep the "entry price" of acquiring a cellular phone as low as possible, so that the carrier can sell the highly profitable cellular service to the largest possible customer base.[3] Thus, our use of the $500 price point for the DSS converter, if anything, may have *understated* the price that would be set in the market were no externalities present. Because both our CICATS and ACATS

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3. Other examples of this practice can also be cited. A classic one is razors vs. blades, with the former being priced at or below cost while the latter makes up any shortfall. Inasmuch as digital television converters will be providing consumers with access to *free* over-the-air broadcasts, there would be no incentive on the part of either the converter manufacturers or the television broadcasters (who will be retaining their analog channels during the entire transition period) to offer similar subsidies.

transition cost estimates are derived from that $500 DSS base price, they too are likely understated. This understatement, however, does not affect the *relationship* between the projected retail prices for the two types of converters.

Refinements to the original study

We have undertaken to make certain refinements to our original study in order to test the sensitivity of our original results to the specific assumptions that had been made. As we demonstrate below, these refinements confirm that our original cost projections were, if anything, on the conservative side.

Refinements to the cost of the ACATS and CICATS converters

As we noted in our original report, the MPEG-2 decoder that is utilized in a digital satellite television converter is similar to that required by both the ACATS and CICATS transition transmission protocols. In our original study, we assumed that for HDTV, an ACATS decoder required five times the processing speed and five times the memory of the basic DSS device. A further refinement of the engineering assumptions, however, now suggests that the full HDTV-capable ACATS decoder would need to process *six* times as much data per second and would use *six* times the memory than is required for SDTV. The output data rate is simply the number of pixels in a frame times the number of frames per second. In ACATS, this is $1920 \times 1080 \times 30 = 62,208,000$ pixels per second. For SDTV, the rate is $704 \times 480 \times 30 = 10,137,600$ pixels per second, giving a ratio of 6.1. Memory used in a decoder is proportional to frame size, so the ratio is $(1920 \times 1080) / (704 \times 480) = 6.1$ as well. For the MPEG-2 decoding process, memory size and data rate translates almost linearly to the cost of the devices involved. Hence, we have modified the base cost estimate for the ACATS HDTV-capable converter to reflect a 6.1 multiplier for the MPEG-2 components of an HDTV-capable ACATS converter to reflect this refinement.

A CICATS base-line format progressive scan decoder would need to process 18,000,000 pixels per second, a ratio of 1.8 relative to the data rate required for satellite TV. The maximum frame size is $512 \times 1024 = 524,288$ pixels, a ratio of 1.6. Accordingly, we are revising the cost of the baseline CICATS converter by using 1.7 as the multiplier for the MPEG-2 components vis-a-vis those required in a conventional satellite television decoder.

These refinements result in slightly higher base retail prices for both the ACATS and the CICATS converters. For 1996, the revised estimate for the retail price of an ACATS converter is $1.584, whereas the price of a CICATS converter would be $649. These changes are reflected in Tables A-1, A-2 and A-3, which correspond to Table 1, 2 and 3 in our earlier report. In Table A-1, we assume that the ACATS standard is adopted and that

ECONOMICS AND
TECHNOLOGY, INC.

only HDTV-capable ACATS converters are offered (ACATS Scenario 1). In Table A-2, we assume that the ACATS standard is adopted but that both HDTV-capable and SDTV-only ACATS converters are offered, with 20% of the converters that are purchased being HDTV-capable and the remaining 80% having only ACATS SDTV capability (ACATS Scenario 2). Table A-3 assumes that the CICATS standard is adopted (CICATS Scenario), and projects costs on that basis.

The results of these three scenarios are as follows:

ACATS Scenario 1	$103.7-billion
ACATS Scenario 2	$65.1-billion
CICATS Scenario	$55.5-billion

Refinements to the rate of digital converter penetration

In our original study, we applied an arbitrary set of assumed penetration rates over the ten-year transition (1998-2007). Such transition patterns are difficult to gauge accurately, in large part because of the significant externalities that are present and that will have a major influence on consumer demand.

In order to test the robustness of our original penetration assumptions, we developed an alternate penetration path based upon the experience gained from the transition from black-and-white to color television. That transition, however, took between twenty and thirty years to complete, depending upon when one considers it to have begun and ended. Although the NTSC color television standard was approved by the FCC in 1953, few stations offered color broadcasts on a regular basis until well into the 1960s, and penetration rates were *de minimis*. Accordingly, we used 1965 as the *de facto* commencement of the color TV transition. Even today, the penetration rate is less than 100% and, since color broadcasts can continue to be received on black-and-white sets, the "end state" is not directly comparable to the case of digital television, where the analog broadcasts will simply cease to exist and non-converted sets will receive no signal at all.

Our approach was to telescope the 20-year color TV migration into a 10-year period by simply taking every other year's penetration experience and applying it to our forecast. The results of this analysis are shown in Tables B-1, B-2 and B-3 for each of our three scenarios. The results of these three cases are as follows:

ACATS Scenario 1	$94.9-billion
ACATS Scenario 2	$60.7-billion
CICATS Scenario	$52.1-billion

ECONOMICS AND
TECHNOLOGY, INC.

Technology assumptions

Our original cost projections assumed that Moore's Law would continue to apply throughout the transition period, such that the cost of the VLSI electronics components in the converter units was projected to decrease by 50% every 24 months. Some observers have recently speculated that this rapid pace of technology-driven cost decreases may not persist indefinitely.[4] To test the sensitivity of our results to the possibility that effect of Moore's Law may have to be modified, we performed our calculations based upon a halving of VLSI costs every 36 months rather than the 24 months we had originally assumed. The results of this sensitivity analysis are shown in Tables C-1, C-2 and C-3 for each of our three scenarios. The results of these three cases are as follows:

ACATS Scenario 1	$150.0-billion
ACATS Scenario 2	$88.5-billion
CICATS Scenario	$73.1-billion

The impact of the alternative scenarios on the demand for converters

In the various analyses that we presented both in our original report and up to now, we have ignored the potential effects of price on the demand for converters. That is, we assumed that the rate of acquisition of converters would be unaffected by price, and thus we applied the same rate of penetration for each of the three scenarios. Obviously, however, price will have a significant impact upon demand. If the higher-priced ACATS units are all that are offered, the rate of consumer acceptance will necessarily be considerably slower than for the less costly CICATS units.

The precise relationship between price and demand cannot be known at this time. However, for purposes both of demonstrating the potential impact of price, as well as testing the overall sensitivity of our results to the different price levels, we have introduced a hypothetical price elasticity of −1.0. Under this "unit elasticity" assumption, each 1% increase in price is assumed to result in a 1% decrease in demand.

To perform this study, we used as a basis the analyses presented in Tables B-1, B-2 and B-3, which incorporated the revised converter cost estimates and a migration pattern based upon that for color television. For this analysis, we assumed that the migration

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4. For example, a recent National Public Radio broadcast suggested that Moore's Law may soon be approaching its limits due to the fact that miniaturization now approaches the dimensions of wavelengths of light, and as such the photographic processes that have been used in the manufacture of VLSI circuits may be incapable of supporting component densities that industry is soon to achieve. National Public Radio, *Morning Edition*, Segment No. 6, "Technology Pushing Miniaturization Frontiers — Part 1," Monday, July 15, 1996.

pattern portrayed in Table B-3 for the CICATS converters would apply at the CICATS price points; thus, Table D-3 is identical to Table B-3. For the higher priced ACATS Scenarios 1 and 2, we applied a unit elastic demand to the CICATS Scenario demand for the purpose of estimating the potential impact of the higher ACATS prices on overall penetration. These results are presented in Tables D-1 and D-2. Here, the aggregate consumer expenditure is held constant (at $52.1-billion) for all three cases, but the penetration rates for the two ACATS scenarios are allowed to vary based upon the relative price differentials between each of these scenarios and the lower CICATS price levels. Using this analysis, we can predict overall penetration rates at the end of the tenth year (2007), as follows:

ACATS Scenario 1 (Table D-1)	62%
ACATS Scenario 2 (Table D-2)	88%
CICATS Scenario (Table D-3)	100% (the default assumption)

While we do not offer our estimate of a −1.0 price elasticity as a precise indicator of the impact of price on demand, it nevertheless offers a useful demonstration of the fact that at the higher ACATS price levels the pace of conversion to digital television will be slower, and there is a significant possibility that by the end of the tenth year there may still be too many unconverted NTSC receivers in place to realistically permit the analog broadcasts to be shut down.

Conclusion

The refinements and sensitivity analyses presented here confirm the fundamental validity of our original analysis, and suggest that it was, if anything, on the conservative side. While further information will permit additional refinements, it seems clear that adoption of the ACATS standard could cost US consumers anywhere from $50-billion to $75-billion more than under the CICATS approach. Moreover, since these costs are only for *converters* and not for any HDTV display receivers themselves, these additional costs will be imposed upon US consumers without producing any particular additional benefits either in functionality or in picture quality. In the absence of any such benefits, these costs would represent a "deadweight loss" to the US economy that will negatively impact our overall productivity and competitiveness on the world market. Before proceeding down this path, the nation needs to be assured that the gains from ACATS will be worth the costs. And for now, no such assurances appear to be forthcoming.

7

ECONOMICS AND
TECHNOLOGY, INC.

Table A-1

TOTAL CONSUMER COST OF ATV CONVERSION
USING FULL HDTV-CAPABLE ACATS CONVERTERS
(Revised Converter Cost and Adoption Pattern)

Year	Total TV set Installed base (end of year) (000)	NTSC Installed base (end of year) (000)	NTSC sets converted in year Pct.	Qty (000)	Unit cost of full-function ACATS converter	Ann cost of ACATS converters ($000)
1996	213,700	213,700	0%	0	$1,584	0
1997	223,000	223,000	0%	0	$1,142	0
1998	232,500	209,250	10%	23,250	$829	19,282,969
1999	242,000	196,875	10%	21,875	$608	13,309,268
2000	252,948	166,258	20%	41,565	$452	18,794,953
2001	264,390	142,161	20%	35,540	$342	12,144,497
2002	276,351	107,885	30%	46,236	$264	12,187,610
2003	288,852	72,232	40%	48,155	$208	10,033,280
2004	301,919	42,649	50%	42,649	$169	7,220,413
2005	315,578	22,523	60%	33,785	$142	4,786,528
2006	329,854	11,040	70%	25,759	$122	3,146,466
2007	344,775	0	100%	25,962	$108	2,812,652
				0		
Cumulative Cost						103,718,634

Sources: Consumer Electronics Information Service, USA Market Forecast, August, 1995;
Unit Cost estimates are based on a study by Steve Gabriel, Microsoft Corporation,
preliminary methodology explained in Exhibit C of CICATS comments.

ECONOMICS AND
TECHNOLOGY, INC.

Table A-2

TOTAL CONSUMER COST OF ATV CONVERSION
USING 20% HDTV, 80% SDTV MIX OF ACATS CONVERTERS
(Revised Converter Cost and Adoption Pattern)

Year	Total TV set Installed base (end of year) (000)	NTSC Installed base (end of year) (000)	NTSC sets converted in year Pct.	NTSC sets converted in year Qty (000)	Wtd. Avg. Unit cost of ACATS converter	Ann cost of ACATS converters ($000)
1996	213,700	213,700	0%	0	$836	0
1997	223,000	223,000	0%	0	$613	0
1998	232,500	209,250	10%	23,250	$455	10,587,469
1999	242,000	196,875	10%	21,875	$344	7,524,251
2000	252,948	166,258	20%	41,565	$265	11,022,389
2001	264,390	142,161	20%	35,540	$209	7,445,057
2002	276,351	107,885	30%	46,236	$170	7,864,512
2003	288,852	72,232	40%	48,155	$142	6,849,568
2004	301,919	42,649	50%	42,649	$123	5,226,553
2005	315,578	22,523	60%	33,785	$109	3,669,703
2006	329,854	11,040	70%	25,759	$99	2,544,341
2007	344,775	0	100%	25,962	$92	2,383,543
				0		
Cumulative Cost						65,117,385

Sources: Consumer Electronics Information Service, USA Market Forecast, August, 1995;
Unit Cost estimates are based on a study by Steve Gabriel, Microsoft Corporation,
preliminary methodology explained in Exhibit C of CICATS comments.

9

ECONOMICS AND
TECHNOLOGY, INC.

Table A-3

TOTAL CONSUMER COST OF ATV CONVERSION
USING CICATS BASE-LINE CONVERTERS
(Revised Converter Cost and Adoption Pattern)

Year	Total TV set Installed base (end of year) (000)	NTSC Installed base (end of year) (000)	NTSC sets converted in year Pct.	NTSC sets converted in year Qty (000)	Unit cost of CICATS base line converter	Ann cost of CICATS converters ($000)
1996	213,700	213,700	0%	0	$649	0
1997	223,000	223,000	0%	0	$481	0
1998	232,500	209,250	10%	23,250	$362	8,413,594
1999	242,000	196,875	10%	21,875	$278	6,077,996
2000	252,948	166,258	20%	41,565	$218	9,079,248
2001	264,390	142,161	20%	35,540	$176	6,270,197
2002	276,351	107,885	30%	46,236	$147	6,783,738
2003	288,852	72,232	40%	48,155	$126	6,053,640
2004	301,919	42,649	50%	42,649	$111	4,728,088
2005	315,578	22,523	60%	33,785	$100	3,390,497
2006	329,854	11,040	70%	25,759	$93	2,393,809
2007	344,775	0	100%	25,962	$88	2,276,266
				0		
Cumulative Cost						55,467,073

Sources: Consumer Electronics Information Service, USA Market Forecast, August, 1995;
Unit Cost estimates are based on a study by Steve Gabriel, Microsoft Corporation,
preliminary methodology explained in Exhibit C of CICATS comments.

ECONOMICS AND
TECHNOLOGY, INC.

Table B-1

TOTAL CONSUMER COST OF ATV CONVERSION
USING FULL HDTV-CAPABLE ACATS CONVERTERS
BASED ON COLOR TV MIGRATION PATTERN AND REVISED CONVERTER COSTS
24-Month Cost-Halving Interval

Year	Total TV set Installed base (end of year) (000)	Total DTV Take Rate Pct.[1]	NTSC sets converted in year Qty (000)	Unit cost of full-function ACATS converter	Ann cost of ACATS converters ($000)
1996	213,700	0%	0	$1,584	$0
1997	223,000	0%	0	$1,142	$0
1998	232,500	5%	11,160	$829	$9,255,825
1999	242,000	16%	28,286	$608	$17,209,872
2000	252,948	32%	41,497	$452	$18,764,523
2001	264,390	41%	27,457	$342	$9,382,323
2002	276,351	55%	44,698	$264	$11,782,193
2003	288,852	68%	44,477	$208	$9,266,971
2004	301,919	77%	35,205	$169	$5,960,071
2005	315,578	81%	22,207	$142	$3,146,218
2006	329,854	86%	29,347	$122	$3,584,707
2007	344,775	100%	60,442	$108	$6,548,188
Cumulative Cost					$94,900,893

Sources: Consumer Electronics Information Service, USA Market Forecast, August, 1995;
NBC, Nielsen, 1955-1984 and EIA Consumer Electronics U.S. Sales;
Unit Cost estimates are based on a study by Steve Gabriel, Microsoft Corporation,
preliminary methodology explained in Exhibit C of CICATS comments.
Notes: 1) Penetration rates are extrapolated from penetration rates of direct-view
color TV receivers, 1965-1983;
2) Cost of memory and computation halves every 24 months.

11

ECONOMICS AND
TECHNOLOGY, INC.

Table B-2

TOTAL CONSUMER COST OF ATV CONVERSION
USING 20% HDTV, 80% SDTV MIX OF ACATS CONVERTERS
BASED ON COLOR TV MIGRATION PATTERN AND REVISED CONVERTER COSTS
24-Month Cost-Halving Interval

Year	Total TV set installed base (end of year) (000)	Total DTV Take Rate Pct.[1]	NTSC sets converted in year Qty (000)	Wtd. Avg. Unit cost of ACATS converter[2]	Ann cost of ACATS converters ($000)
1996	213,700	0%	0	$836	$0
1997	223,000	0%	0	$613	$0
1998	232,500	5%	11,160	$455	$5,081,985
1999	242,000	16%	28,286	$344	$9,729,415
2000	252,948	32%	41,497	$265	$11,004,544
2001	264,390	41%	27,457	$209	$5,751,735
2002	276,351	55%	44,698	$170	$7,602,902
2003	288,852	68%	44,477	$142	$6,326,421
2004	301,919	77%	35,205	$123	$4,314,245
2005	315,578	81%	22,207	$109	$2,412,122
2006	329,854	86%	29,347	$99	$2,898,718
2007	344,775	100%	60,442	$92	$5,549,171
Cumulative Cost					$60,671,257

Sources: Consumer Electronics Information Service, USA Market Forecast, August, 1995;
NBC, Nielsen, 1955-1984 and EIA Consumer Electronics U.S. Sales;
Unit Cost estimates are based on a study by Steve Gabriel, Microsoft Corporation,
preliminary methodology explained in Exhibit C of CICATS comments.
Notes: 1) Penetration rates are extrapolated from penetration rates of direct-view
color TV receivers, 1965-1983;
2) Cost of memory and computation halves every 24 months.

ECONOMICS AND
TECHNOLOGY, INC.

Table B-3

TOTAL CONSUMER COST OF ATV CONVERSION
USING CICATS BASE-LINE CONVERTERS
BASED ON COLOR TV MIGRATION PATTERN AND REVISED CONVERTER COSTS
24-Month Cost-Halving Interval

Year	Total TV set Installed base (end of year) (000)	Total DTV Take Rate Pct.[1]	NTSC sets converted in year Qty (000)	Unit cost of CICATS base line converter[2]	Ann cost of CICATS converters ($000)
1996	213,700	0%	0	$649	$0
1997	223,000	0%	0	$481	$0
1998	232,500	5%	11,160	$362	$4,038,525
1999	242,000	16%	28,286	$278	$7,859,301
2000	252,948	32%	41,497	$218	$9,064,549
2001	264,390	41%	27,457	$176	$4,844,088
2002	276,351	55%	44,698	$147	$6,558,079
2003	288,852	68%	44,477	$126	$5,591,284
2004	301,919	77%	35,205	$111	$3,902,788
2005	315,578	81%	22,207	$100	$2,228,597
2006	329,854	86%	29,347	$93	$2,727,221
2007	344,775	100%	60,442	$88	$5,299,416
Cumulative Cost					$52,113,848

Sources: Consumer Electronics Information Service, USA Market Forecast, August, 1995;
NBC, Nielsen, 1955-1984 and EIA Consumer Electronics U.S. Sales;
Unit Cost estimates are based on a study by Steve Gabriel, Microsoft Corporation,
preliminary methodology explained in Exhibit C of CICATS comments.
Notes: 1) Penetration rates are extrapolated from penetration rates of direct-view
color TV receivers, 1965-1983;
2) Cost of memory and computation halves every 24 months.

ECONOMICS AND
TECHNOLOGY, INC.

Table C-1

TOTAL CONSUMER COST OF ATV CONVERSION
USING FULL HDTV-CAPABLE ACATS CONVERTERS
BASED ON COLOR TV MIGRATION PATTERN AND REVISED CONVERTER COSTS
36-Month Cost-Halving Interval

Year	Total TV set Installed base (end of year) (000)	Total DTV Take Rate Pct.	NTSC sets converted in year Qty (000)	Unit cost of full-function ACATS converter	Ann cost of ACATS converters ($000)
1996	213,700	0%	0	$1,584	$0
1997	223,000	0%	0	$1,272	$0
1998	232,500	5%	11,160	$1,025	$11,444,055
1999	242,000	16%	28,286	$829	$23,459,701
2000	252,948	32%	41,497	$674	$27,958,661
2001	264,390	41%	27,457	$550	$15,107,474
2002	276,351	55%	44,698	$452	$20,212,013
2003	288,852	68%	44,477	$374	$16,650,894
2004	301,919	77%	35,205	$313	$11,005,503
2005	315,578	81%	22,207	$264	$5,853,581
2006	329,854	86%	29,347	$225	$6,593,920
2007	344,775	100%	60,442	$194	$11,713,994
Cumulative Cost					$149,999,796

Sources: Consumer Electronics Information Service, USA Market Forecast, August, 1995;
NBC, Nielsen, 1955-1984 and EIA Consumer Electronics U.S. Sales;
Unit Cost estimates are based on a study by Steve Gabriel, Microsoft Corporation,
preliminary methodology explained in Exhibit C of CICATS comments.
Notes: 1) Penetration rates are extrapolated from penetration rates of direct-view
color TV receivers, 1965-1983;
2) Cost of memory and computation halves every 36 months.

ECONOMICS AND
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Table C-2

TOTAL CONSUMER COST OF ATV CONVERSION
USING 20% HDTV, 80% SDTV MIX OF ACATS CONVERTERS
BASED ON COLOR TV MIGRATION PATTERN AND REVISED CONVERTER COSTS
36-Month Cost-Halving Interval

Year	Total TV set installed base (end of year) (000)	Total DTV Take Rate Pct.	NTSC sets converted in year Qty (000)	Wtd. Avg. Unit cost of ACATS converter	Ann cost of ACATS converters ($000)
1996	213,700	0%	0	$836	$0
1997	223,000	0%	0	$679	$0
1998	232,500	5%	11,160	$554	$6,185,346
1999	242,000	16%	28,286	$455	$12,880,737
2000	252,948	32%	41,497	$377	$15,640,461
2001	264,390	41%	27,457	$315	$8,638,501
2002	276,351	55%	44,698	$265	$11,853,431
2003	288,852	68%	44,477	$226	$10,049,582
2004	301,919	77%	35,205	$195	$6,858,279
2005	315,578	81%	22,207	$170	$3,777,243
2006	329,854	86%	29,347	$150	$4,416,039
2007	344,775	100%	60,442	$135	$8,153,901
Cumulative Cost					$88,453,520

Sources: Consumer Electronics Information Service, USA Market Forecast, August, 1995;
NBC, Nielsen, 1955-1984 and EIA Consumer Electronics U.S. Sales;
Unit Cost estimates are based on a study by Steve Gabriel, Microsoft Corporation,
preliminary methodology explained in Exhibit C of CICATS comments.
Notes: 1) Penetration rates are extrapolated from penetration rates of direct-view
color TV receivers, 1965-1983;
2) Cost of memory and computation halves every 36 months.

ECONOMICS AND
TECHNOLOGY, INC.

Table C-3

TOTAL CONSUMER COST OF ATV CONVERSION
USING CICATS BASE-LINE CONVERTERS
BASED ON COLOR TV MIGRATION PATTERN AND REVISED CONVERTER COSTS
36-Month Cost-Halving Interval

Year	Total TV set Installed base (end of year) (000)	Total DTV Take Rate Pct.	NTSC sets converted in year Qty (000)	Unit cost of CICATS base line converter	Ann cost of CICATS converters ($000)
1996	213,700	0%	0	$649	$0
1997	223,000	0%	0	$530	$0
1998	232,500	5%	11,160	$436	$4,870,669
1999	242,000	16%	28,286	$362	$10,235,996
2000	252,948	32%	41,497	$303	$12,560,911
2001	264,390	41%	27,457	$256	$7,021,258
2002	276,351	55%	44,698	$218	$9,763,785
2003	288,852	68%	44,477	$189	$8,399,254
2004	301,919	77%	35,205	$165	$5,821,473
2005	315,578	81%	22,207	$147	$3,258,158
2006	329,854	86%	29,347	$132	$3,871,569
2007	344,775	100%	60,442	$120	$7,263,878
Cumulative Cost					$73,066,952

Sources: Consumer Electronics Information Service, USA Market Forecast, August, 1995;
NBC, Nielsen, 1955-1984 and EIA Consumer Electronics U.S. Sales;
Unit Cost estimates are based on a study by Steve Gabriel, Microsoft Corporation,
preliminary methodology explained in Exhibit C of CICATS comments.
Notes: 1) Penetration rates are extrapolated from penetration rates of direct-view
color TV receivers, 1965-1983;
2) Cost of memory and computation halves every 36 months.

Table D-1

CONSUMER PENETRATION RATES OF DTV CONVERTERS AS AFFECTED BY THEIR PRICES
FULL HDTV-CAPABLE ACATS CONVERTERS
24-Month Cost-Halving Interval

Year	Total TV set Installed base (end of year) (000)	Total DTV Take Rate Pct.	NTSC sets converted in year (000)	Unit cost of full-function ACATS converter	Ann cost of ACATS converters ($000)
1996	213,700	0%	0	$1,584	$0
1997	223,000	0%	0	$1,142	$0
1998	232,500	2%	4,869	$829	$4,038,525
1999	242,000	7%	12,917	$608	$7,859,301
2000	252,948	15%	20,046	$452	$9,064,549
2001	264,390	20%	14,176	$342	$4,844,088
2002	276,351	28%	24,879	$264	$6,558,079
2003	288,852	36%	26,835	$208	$5,591,284
2004	301,919	42%	23,053	$169	$3,902,788
2005	315,578	45%	15,730	$142	$2,228,597
2006	329,854	50%	22,327	$122	$2,727,221
2007	344,775	62%	48,915	$108	$5,299,416
Cumulative Cost			213,749		$52,113,848

Sources: Consumer Electronics Information Service, USA Market Forecast, August, 1995;
NBC, Nielsen, 1955-1984 and EIA Consumer Electronics U.S. Sales;
Unit Cost estimates are based on a study by Steve Gabriel, Microsoft Corporation,
preliminary methodology explained in Exhibit C of CICATS comments.
Notes: 1) Penetration rates are extrapolated from penetration rates of direct-view
color TV receivers, 1965-1983;
2) Cost of memory and computation halves every 24 months.

ECONOMICS AND
TECHNOLOGY, INC.

Table D-2

CONSUMER PENETRATION RATES OF DTV CONVERTERS AS AFFECTED BY THEIR PRICES
20% HDTV, 80% SDTV MIX OF ACATS CONVERTERS
24-Month Cost-Halving Interval

Year	Total TV set Installed base (end of year) (000)	Total DTV Take Rate Pct.	NTSC sets converted in year (000)	Wtd. Avg. Unit cost of ACATS converter	Ann cost of ACATS converters ($000)
1996	213,700	0%	0	$836	$0
1997	223,000	0%	0	$613	$0
1998	232,500	4%	8,869	$455	$4,038,525
1999	242,000	13%	22,849	$344	$7,859,301
2000	252,948	26%	34,182	$265	$9,064,549
2001	264,390	34%	23,124	$209	$4,844,088
2002	276,351	46%	38,556	$170	$6,558,079
2003	288,852	58%	39,308	$142	$5,591,284
2004	301,919	66%	31,847	$123	$3,902,788
2005	315,578	69%	20,517	$109	$2,228,597
2006	329,854	75%	27,611	$99	$2,727,221
2007	344,775	88%	57,721	$92	$5,299,416
Cumulative Cost					$52,113,848

Sources: Consumer Electronics Information Service, USA Market Forecast, August, 1995;
NBC, Nielsen, 1955-1984 and EIA Consumer Electronics U.S. Sales;
Unit Cost estimates are based on a study by Steve Gabriel, Microsoft Corporation,
preliminary methodology explained in Exhibit C of CICATS comments.
Notes: 1) Penetration rates are extrapolated from penetration rates of direct-view
color TV receivers, 1965-1983;
2) Cost of memory and computation halves every 24 months.

Table D-3

CONSUMER PENETRATION RATES OF DTV CONVERTERS AS AFFECTED BY THEIR PRICES
CICATS BASE-LINE CONVERTERS
24-Month Halving Interval

Year	Total TV set Installed base (end of year) (000)	Total DTV Take Rate Pct.	NTSC sets converted in year (000)	Unit cost of CICATS base line converter	Ann cost of CICATS converters ($000)
1996	213,700	0%	0	$649	$0
1997	223,000	0%	0	$481	$0
1998	232,500	5%	11,160	$362	$4,038,525
1999	242,000	16%	28,286	$278	$7,859,301
2000	252,948	32%	41,497	$218	$9,064,549
2001	264,390	41%	27,457	$176	$4,844,088
2002	276,351	55%	44,698	$147	$6,558,079
2003	288,852	68%	44,477	$126	$5,591,284
2004	301,919	77%	35,205	$111	$3,902,788
2005	315,578	81%	22,207	$100	$2,228,597
2006	329,854	86%	29,347	$93	$2,727,221
2007	344,775	100%	60,442	$88	$5,299,416
Cumulative Cost					$52,113,848

Sources: Consumer Electronics Information Service, USA Market Forecast, August, 1995;
NBC, Nielsen, 1955-1984 and EIA Consumer Electronics U.S. Sales;
Unit Cost estimates are based on a study by Steve Gabriel, Microsoft Corporation,
preliminary methodology explained in Exhibit C of CICATS comments.
Notes: 1) Penetration rates are extrapolated from penetration rates of direct-view
color TV receivers, 1965-1983;
2) Cost of memory and computation halves every 24 months.

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Certificate of Service

I, Noel Manalo, hereby certify that true and correct copies of the preceding Reply Comments of the Computer Industry Coalition on Advanced Television Service in the Matter of Advanced Television Systems and their Impact Upon the Existing Television Broadcast Service, MM Docket No. 87-268, Fifth Further Notice of Proposed Rulemaking were served this 12th day of August, 1996 via hand delivery upon the following:

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Noel Manalo
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August 12, 1996